Developing Training Programs to Prevent Injury in Young Racehorses

An investigation into exercise accumulation and early intervention treadmill training programs in young horses

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Overview

In this project we investigated the effects of exercise accumulation and age on bone adaptation in young horses exercised on a high-speed treadmill. The purpose was to better understand the level of high-speed exercise that may induce positive adaptation in the third metacarpal bone (MCIII) without inducing fatigue injury in young horses.

Shin soreness is one of the most common causes of wastage in the Thoroughbred industry (Cogger et al., 2006). An improved understanding of the mechanisms contributing to shin soreness, and development of optimal training techniques that may reduce the risk of shin soreness have the potential for significant beneficial impacts for the racing industry both financially and for the welfare of the horses.

Who should be interested in the findings?

This report will be of interest to racehorse owners and trainers, veterinarians, researchers and racing administrators with an interest in exercise and bone fatigue-injury in horses.

Background

Shin soreness, or dorsal metacarpal disease (DMD) is a condition of pain and swelling over the dorsal aspect of the third metacarpal bone (cannon bone). It is thought to arise as a result of cyclical loading that occurs during high-speed exercise, resulting in fatigue-related, proliferative periosteal new bone (Nobushige et al., 2001; Nunamaker et al., 1990; Riggs et al., 2002). Bone is a dynamic tissue that is able to adapt to increased levels of loading by improving its geometry and microstructure to withstand higher loads. Galloping exercise that generates high-strain loading through the bones is required to stimulate bone to develop appropriately for the rigors of racing. However a lot of repetitive loading at this high strain over a short period of time can lead to fatigue injury to the bone. Age and workload have been identified as major risk factors for development of shin soreness, with two-year-old horses and those rapidly accumulating a large quantity of high-speed exercise appearing to be most at risk. Exposing the equine cannon bone to short distances of high speed exercise may still produce positively adapted bone without causing fatigue damage.

Evidence from research in other species suggests that bone in young animals has much more potential to undergo adaptive change than mature bone (Forwood 2008).
Aims/objectives

The aim of this project was to evaluate the effects of exercise accumulation and age on bone adaptation in young horses exercised on a high-speed treadmill using computed tomography (CT) and MCIII bone biopsy as tools to examine changes in bone geometry and structure.

The specific objectives of the project were to:

- Determine if differences in bone adaptation can be detected in 2 year old horses that are galloped increasing distances on a treadmill 3 days per week and compare any changes with horses galloped short distances on one day per week.
- Use a novel technique for bone biopsy in the third metacarpal bone (MCIII) to determine the effect of high-speed treadmill training on cortical remodelling and microdamage in the third metacarpus during early introduction of fast work in previously untrained 2 year old horses.
- Determine if the early introduction of a high intensity treadmill training regimen can be safely used to alter bone geometry and density in weanling horses.

Methods used

Two main studies were carried out to investigate the effects of age and exercise accumulation on bone adaptation of the MCIII in young horses.

In the first study, two-year-old horses were exercised on a treadmill using two different regimens differing in quantities of exercise performed at high speed to investigate if a small amount of exercise at speeds greater than 12 metres per second (m/s) would be sufficient to produce MCIII adaptation without inducing pathology.

In the second study, weanling horses were exposed to high intensity treadmill exercise at speeds up to 12m/s to determine the effects of an early-intervention training program on the geometry of the MCIII in weanling horses.

All animals were examined for lameness throughout each trial. The MCIII of both cohorts of horses were evaluated pre- and post-treatment using CT imaging and analysis. Five of the two-year-old horses underwent a pre-trial biopsy of their left MCIII to evaluate histology and histomorphometry of bone prior to starting training. Four of the 2 year old horses required euthanasia for reasons unrelated to the trial. Bone samples were obtained from the MCIII bone to examine for any changes in microdamage accumulation or remodelling that might have been induced by the treadmill training.

Results/key findings

Bone biopsy of the MCIII yielded histological samples that allowed bone tissue to be examined from the same horse before and after an imposed treadmill training program. CT imaging provided high quality digital images of the equine cannon bone that were easily calibrated using an appropriate reference phantoms of known water- and bone-equivalent material. Analysis of CT images was a sensitive tool for detecting changes in bone geometry over time or in response to biopsy.

Under conditions of imposed treadmill-based high-speed exercise in two-year-old horses over a twelve week period we observed no significant effects on bone geometry in groups exercised at high and low intensity compared with unexercised controls. No significant accumulation of microdamage was detected in response to treadmill training. Both groups of horses showed no evidence of lameness or joint injury.

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These results suggest that short term high intensity treadmill-based exercise in two-year-old horses does not appear to cause rapid changes in the MCIII bone but that this type of training appears to be safe and may have benefit in two-year-old horses for conditioning and recovery from injury.

In weanling horses worked at high intensity over a fourteen week period, significant lameness and joint effusion was noted to occur at a similar accumulation of high speed exercise in most of the exercised horses. This lameness coincided with progressive pain on flexion of the carpus and effusion in high-motion joints and was considered to be associated with the treadmill exercise. Lameness resolved after a period of detraining.

No evidence of geometric changes was noted in the exercised horses compared with the unexercised controls, suggesting that in weanling horses, lameness and joint inflammation will occur before significant bone adaptation when exercised at high intensity over a 2 to 3 month period of time. However, high intensity treadmill exercise imposed early in the life of a horse does not appear to cause irreversible injury to the fetlocks, cannon bone or carpal joints.

**Implications for relevant stakeholders**

The first study aimed to show a difference in bone geometric changes and microstructure between two groups of two-year-old horses performing high speed galloping either three days per week or one day per week in a short term training program on a high speed treadmill. Despite the high intensity exercise group completing between 113 and 131 km of total exercise, and between 12 and 14 km of exercise at 14 m/s (50 km/Hr) we failed to show significant adaptive changes in the cannon bone compared with the low intensity exercise or control groups. Even with high intensity training, treadmill exercise may not generate sufficient load or variation in stride to create the very high strains needed for bone to respond with adaptive modelling in 2 year old horses.

In the second study, exercising weanling horses at high speeds in an intensive training regimen resulted in lameness and synovitis without evidence of bone adaptation. However most of the weanlings were able to perform large distances at fast speed before lameness developed. Weanling horses adapted very quickly to the use of an equine treadmill, and were able to achieve high speeds (12 m/s, or 43 km/hour) without difficulty. It was only after approximately 20 km of accumulated distance at speeds of 12 m/s over an 8 week period that the majority of exercised weanlings became mildly lame.

These results suggest that training weanling horses on treadmills is likely to be safe at lower intensity of exercise and treadmill-based exercise is a potential tool for pre-training and conditioning young horses to cope with a racing preparation. Lameness and pain on flexion in these animals resolved after cessation of training. Exercise programs with less speed or distance, less frequent fast work or a more prolonged training period at lower intensity may not lead to lameness. Whether different treadmill training regimens in young horses have the potential to induce protective bone adaptation is still not clear.

**Recommendations**

Treadmill training may have a role in weanling horses to prepare them for later racing life. However lameness may occur if large distances at high speed are undertaken. Distances over 1000 metres per week at speeds over 12 m/sec presented a significant risk for the development of lameness in horses aged 8 to 10 months old but training intensity lower than this is likely to be safe in this age horse. (continues overleaf)
The possibility that exercise introduced early in a horse's life could help to protect it against injury as a racehorse is still very tantalising. Treadmill exercise would be much more practical in this age group before ridden exercise can utilised. While intensive introduction of galloping over an 8 week period caused lameness, a longer duration training program with less frequent and shorter periods of fast work may prove to be beneficial.

CT is an effective method of detecting changes in MCIII bone geometry and density and appears to be safe enough to be used in a clinical setting to monitor changes in MCIII shape and structure in response to real-world training programs.

There is now a large volume of evidence that the huge loss to the industry from shin soreness and other musculoskeletal injuries could be prevented by different training strategies. It is critical that further high-quality research be undertaken in this area.

In order to better develop training strategies for reducing the incidence of shin soreness and musculoskeletal injury in young racehorses, track-based, prospective studies investigating the outcomes from different training programs are needed.

**Publications arising from this project**


Barton A, Forwood M, Kidd L Exercise intervention in very young horses – A Review. 2013 *Manuscript in preparation*


**Cited references**


**For more information**

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